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DISINFECTION
OF
SEED POTATOES

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INTRODUCTION.

The disinfection of potato tubers intended for seed is one means of reducing damage from certain diseases which affect this crop. The beneficial effects of seed disinfection may be twofold: first, a cleaner and therefore more saleable crop of tubers; second, a considerable increase in yield. The increase in yield alone may be sufficient to pay for the cost of the treatment several times over.

Seed disinfection kills only those disease germs which are present on or near the surface of the tubers. This is very important however, as such organisms are likely to be especially virulent and moreover are favorably situated for attacking the resulting plant. It should not be expected that seed treatment will give one hundred per cent. control, for disease organisms are commonly present in the soil, and seed disinfection gives little or no protection against soil-borne organisms.

As might be expected, the most pronounced beneficial results of disinfection of seed tubers results when it is necessary to use potatoes for seed which are to some degree diseased. As even certified seed may be slightly diseased this means that most seed lots should be treated. It is always advisable to select for seed, tubers which are as nearly free from infection as possible. Badly diseased tubers should always be discarded and only the cleanest saved for seed. The selection may well begin in the field by discarding unthrifty hills. This should be followed by bin selection, to remove the worst affected tubers. The remainder which are saved will rarely be entirely free from infection. Proper disinfection will kill the surface-borne organisms and at cutting time any tubers showing internal rots should be discarded as the organisms causing such rots will not have been reached by the disinfectants.

There are three common diseases of the potato occurring in Alberta, which are affected by seed treatment. These are black scurf or the *Rhizoctonia* disease, common scab and blackleg. The value of seed treatment for these diseases is approximately in the order mentioned.

BLACK SCURF OR RHIZOCTONIA DISEASE.

The Rhizoctonia disease is one of the most prevalent and destructive seed-borne diseases of the potato. It is a very common disease in Alberta. Black specks found on the surface of mature tubers which will not wash off, are evidences of the presence of this disease (Figure 1). While these disfigure the tubers, they do not injure them greatly. The chief damage is done after sprouts are sent up following the germ-

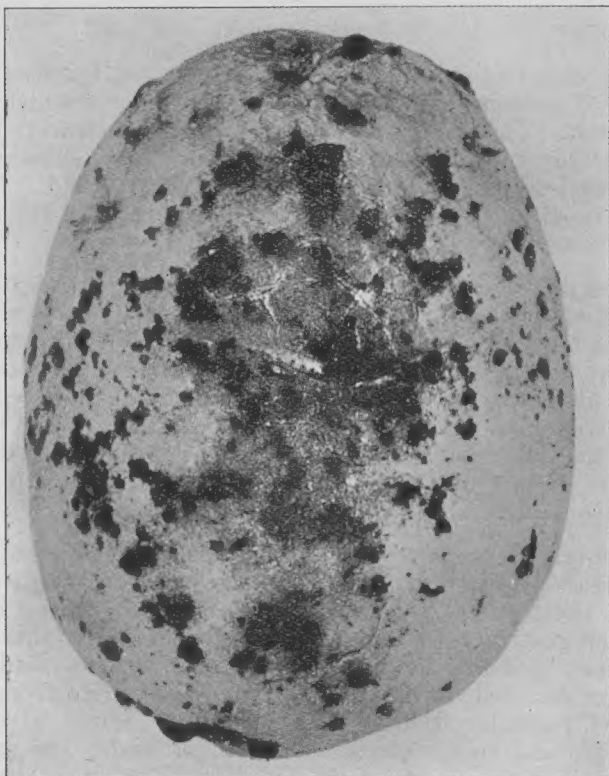


Figure 1.—Potato tuber affected with black scurf or Rhizoctonia. The black lumps are sclerotia of the causal fungus (after Morse and Shapovalov).

ination of the tubers. These and other underground parts of the plant develop brown cankers (Figure 2) which often girdle the affected part. This may cause various abnormalities of the plant, resulting in serious reduction in yield if many plants are affected. When the main stem is severely cankered the tops often turn yellow and wilt or ripen prematurely. Sometimes the water and food conducting tissues are damaged and cannot function properly. As a result small tubers may be formed on the tops. The development of the tubers under-

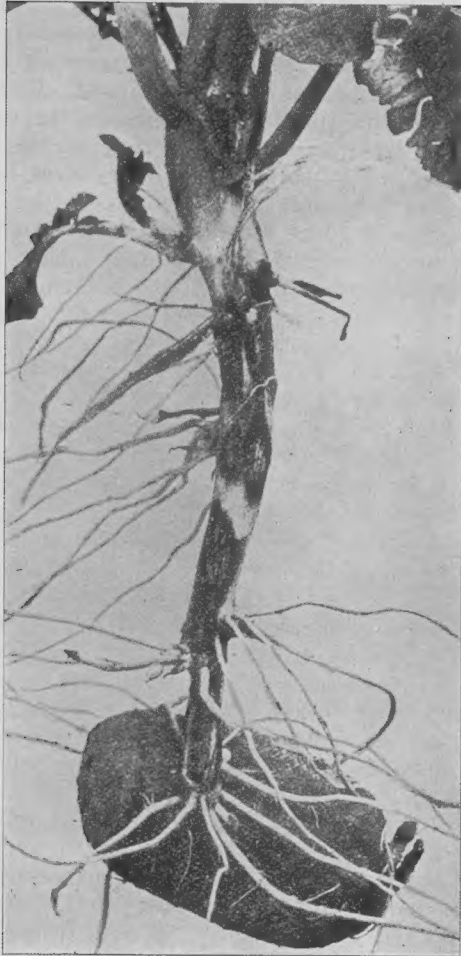


Figure 2.—Potato plant showing *Rhinoctonia* cankers on the stem (after McKay).

ground is often interfered with, so that small tubers result. Clusters of these the size of marbles are sometimes formed close to the main stem.

This disease is caused by a micro-organism belonging to the group of mold-like plants known as fungi. The small black lumps produced on the surface of potato tubers consist of dense masses of the vegetative strands of the fungus. These are dormant resistant structures, and constitute one of the stages in which the organism is able to live over from one growing season to the next. They are able to resume growth when the tubers bearing them are planted, and a thread-like growth is developed which may invade the underground parts

of the plant and produce the characteristic cankers of the disease. In addition to living a parasitic existence on the potato and certain other plants, this organism is also able to live apart from the plant in the soil itself. The vegetative strands of the fungus, like the underground part of a mushroom, are able to live for extended periods in the soil. They may be found in fact in soils which have never borne a crop of potatoes. Furthermore, potato plants often become infected from such soil-borne strands of the organism. It was thought for a long time that this fungus existed only in the vegetative stages just described, in which form it was known as *Rhizoctonia*. A fruiting or spore-bearing stage, however, is now known, and has been given the name *Corticium vagum*. This is the proper name now applied by scientists to the causal organism. The spores produced in this stage correspond to the seeds of higher plants. They are formed in a whitish growth at the base of stems of affected plants just above the ground line. This stage, however, does not seem to be essential in the life of the fungus.

In this disease then, there are two main sources of infection: (1) the black bodies or sclerotia on the surface of seed potatoes, and (2) strands of the fungus or sclerotia in the soil or on other susceptible plants besides the potato. The sclerotia on seed potatoes can be killed by the use of proper disinfectants, and thus this important source of infection can be destroyed. Few lots of seed potatoes are entirely free from sclerotia, so that it is rare that seed disinfection is not of some value. Seed selection for freedom from sclerotia should of course always precede disinfection. If the sclerotia are quite numerous on the seed tubers the effect of tuber treatment in reducing damage to the crop may be very marked as is shown in Table 1. While seed treatment results may be of great value in controlling this disease, other sources of infection should not be disregarded. Since infection may come from contaminated soils it is important to reduce this danger as much as possible. The most practical way is to practise a rotation in which potatoes are grown only once in several years on the same land. The more frequently potatoes are grown the more badly is the land likely to be contaminated with the organism. Non-susceptible crops like cereals should be grown between successive crops of potatoes. Digging of the potatoes promptly may reduce the number of sclerotia formed on them, so that where possible delayed digging should be avoided.

COMMON SCAB.

Common Scab is perhaps the best-known disease of the potato. It is a familiar disease wherever the potato is grown and used. Few lots of potatoes are free from the blemishes

characteristic of this disease. These, as shown in Figure 3, consist of ruptured, corky spots scattered over the surface of the tubers. They detract from the appearance of the tubers, rendering them less saleable. In paring affected potatoes, considerable waste results due to the thicker peeling necessary. Scabby potatoes decay more readily than normal ones as rot-

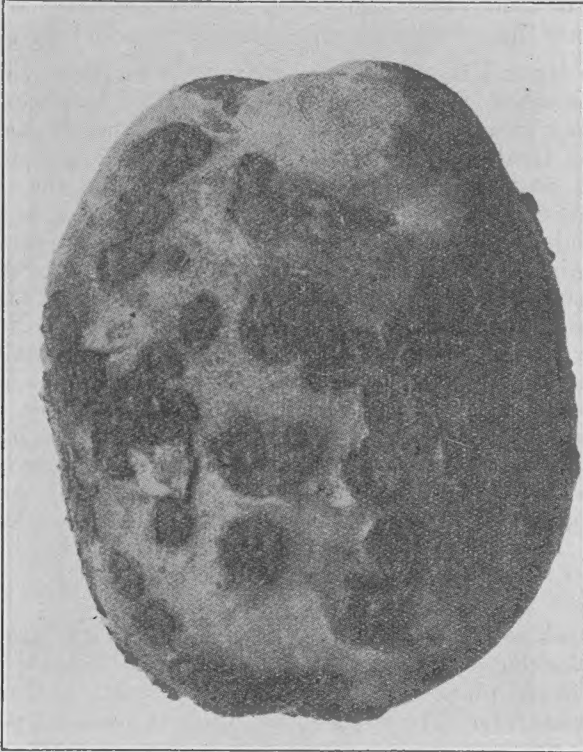


Figure 3.—Potato tuber affected with common scab (after Stakman).

producing organisms can enter the former more easily. They are less desirable for seed, for if untreated, will often give much reduced yields.

The cause of common scab in potatoes is another micro-organism, belonging to the filamentous bacteria and known under the name *Actinomyces scabies*. The scabby spots on infected tubers contain the very fine thread-like organism. If such tubers are used for seed without disinfection, the new crop is very likely to become infected. The scab organism also occurs commonly in the soil. Even virgin soils may contain strains of *Actinomyces* which are capable of producing scab in the potato. It is true that potatoes planted on scab-infested soils do not always become scabby. Certain environmental factors have an important relation to infection. If the

soil for instance is wet during the early development of the tubers, they may remain free from scab even though the soil be heavily infested. If, on the other hand, the soil is dry at this time, the tubers may be very severely attacked by scab. Soil temperature and soil reaction also influence the amount of scab infection. It is well known, for instance, that lime or wood ashes, added to land intended for potatoes, are likely to increase the severity of scab infection considerably.

Scab control is not an easy matter. Complete control by present methods need not be expected. Seed treatment, however, is one means of reducing damage from this disease. Since the same treatments used for *Rhizoctonia* are effective also for scab, only one treatment need be given, and the situation is therefore simplified to that extent. Proper disinfection can be depended upon to kill the scab germs, which are seed-borne, and this is often effective in reducing the severity of infection on the potatoes grown from the treated seed. Seed treatment will not prevent infection from soil-borne scab. Nor is it possible to rid the soil of the organism by rotation, but rotation is advisable as the severity of the disease is likely to be greater on land continually cropped to potatoes. Reduction in amount of scab is sometimes obtained by plowing under a green crop such as rye in the spring before planting potatoes. Russet-skinned potatoes, though not so generally grown as smooth-skinned varieties, enjoy a much greater freedom from scab.

BLACKLEG.

A black soft rot of the base of the stem is a characteristic of the blackleg disease, and from this it gets its name (Figure 4). Affected plants turn yellow and frequently fall over and die prematurely. The rot usually starts in the seed piece and proceeds up the stem to several inches above the ground. The tubers often become infected through the underground stems which bear them. Affected tubers may rot in the soil or later in the bin. There may develop, however, only a black ring in the conducting tissues at the stem end of the tuber. Such infected tubers, if used for seed, may transmit the organism to the next crop. The causal organism, a bacterial parasite *Bacillus phytophthorus*, is also known to live over winter in the soil, and healthy seed pieces may become infected from this source. An insect known as the seed-corn maggot is also able to inoculate seed pieces, after becoming contaminated with the organism. The seed piece is able to ward off infection under certain conditions by the formation of corky layers of cells, but in wet soils where the air supply is poor, they may not be able to do so. Under such conditions most damage from blackleg is likely to occur.

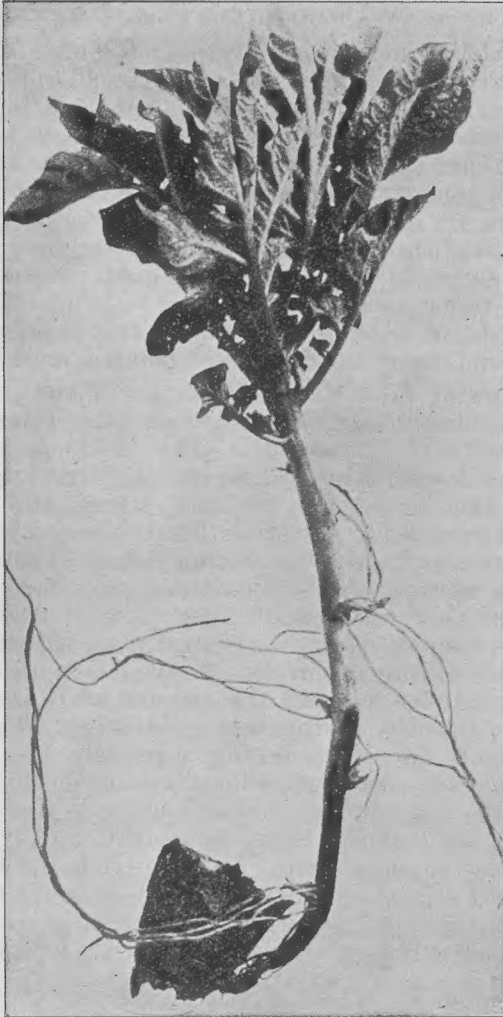


Figure 4.—Blackleg of the potato (after McKay).

Disinfection of seed tubers, at least in some experiments, has reduced the percentage of blackleg plants in the resulting crop and early decay of seed pieces. Certain disinfectants in which mercury is the disinfecting agent appear to be of especial value. It is of considerable importance in the control of this disease to select the seed stock carefully from healthy plants, and to discard at cutting time any tubers which show internal discoloration. It is also advisable to avoid for potato planting, fields or parts of fields which are likely to be waterlogged or very wet after the crop is planted.

METHODS OF DISINFECTING SEED POTATOES.

The chemicals most commonly used for disinfecting seed potatoes are corrosive sublimate (mercuric chloride) and formalin (formaldehyde). These are both used in liquid form. In recent years a number of new disinfectants have been manufactured by chemical companies. Many of these are organic mercury compounds. Some are applied in dust form, but most of them are intended for use in liquid form. The treatment is accomplished in several of the latter simply by dipping the potatoes in and out of the liquid. An endeavor is being made to get away from the long soaks necessary in the older methods, in order to save time. This is especially important where large quantities of seed potatoes must be treated.

The following table shows the results of one year's trials (1929) of a number of disinfectants, on Bliss Triumph potatoes infected with Rhizoctonia. The yield, percentage of plants infected with Rhizoctonia and the degree or severity of the infection recorded in per cent, are given. The older or standard treatments are given first, followed by some of the newer treatments which are being tested. The results are based on an average of five distributed plots for each treatment. Each plot consisted of three rows of 25 hills each. Yields were computed from the central rows of each plot, the two side rows serving as borders. In these tests all treatments except Semesan Bel reduced the amount of Rhizoctonia infection significantly in the subsequent crop. Two of the new treatments appear promising, especially the acidulated mercuric chloride treatment, which is a much quicker treatment than the old standard mercuric chloride treatment, and Cal K, a product of the Bayer-Semesan Company, which is used as an instantaneous dip. In these trials the latter gave almost perfect control of Rhizoctonia. These newer treatments, however, need further testing before they can be recommended for general use. If they are used by growers it would be best to test them in a small way first.

TABLE 1.

Results of treating Rhizoctonia infected seed tubers with different disinfectants at the University of Alberta in 1929.

Treatment.	Yield per acre, bus.	Plants infected, %	Degree of infection, %
Standard Methods:			
Untreated—Check	219.1	46.8	22.7
Corrosive sublimate	243.5	24.8	9.5
4 oz. corrosive sub., 25 gals. water, treated 1½ hours.			
Formaldehyde—cold	263.3	21.2	7.7
1 pint formaldehyde, 30 gals. water, treated 1½ hours.			
Formaldehyde—hot (124°F.)..	297.1	31.4	12.3
1 pint formaldehyde, 15 gals. water, treated 3-4 mins.			

Treatment.	Yield per acre, bus.	Plants in- fected, %	Degree of infection, %
New methods—on trial:			
⊕ Acidulated corrosive sublimate* 7 oz. corrosive sub., 1 qt. hydrochloric acid, 21 gals. water, treated 5 mins.	242.7	18.6	5.9
Ditto, but treated 10 mins.*....	254.6	13.2	3.9
Semesan Bel.	264.1	39.0	17.4
Instantaneous dip.			
Cal K	235.8	0.9	0.3
Instantaneous dip.			
664	254.1	25.3	10.2
Instantaneous dip.			

*Tentative directions supplied by Dr. J. G. Leach, University of Minnesota.

WHICH DISINFECTANT TO USE.

The decision as to which of the standard disinfectants is to be used must rest with the grower. The two which for some time have been in most general favor are corrosive sublimate and hot formaldehyde. Some workers have found the latter more effective against scab, while others report corrosive sublimate somewhat more effective in controlling Rhizoctonia and blackleg. Both are good disinfectants, so the decision as to which shall be used may well rest on other factors. If the quantity of tubers to be treated is large, the quicker hot-formalin treatment will probably be preferred, while if only a few tubers are to be treated corrosive sublimate will probably be more convenient.

PREPARATION AND APPLICATION OF DISINFECTANTS.

Corrosive sublimate. This chemical is a deadly poison. Hence potatoes treated with it are unfit for food. As it corrodes metals, the containers used should be wooden, earthenware, concrete or of some non-metallic material. Sacks should not be employed as they weaken the solution by absorbing the chemical. If the tubers are dirty it is advisable to wash them clean before they are treated, as the dirt also absorbs the chemical and therefore weakens the solution.

The standard corrosive sublimate or mercuric chloride solution is made up by adding 4 ounces of the crystals to 25 gallons of water. It is advisable to dissolve the crystals first in a little hot water and then add this solution to more water to make up the 25 gallons. This quantity is sufficient to treat about 25 bushels of loose potatoes. The tubers should be soaked in the solution for 1½ to 2 hours. After treating each 4 bushels of tubers ½ ounce of corrosive sublimate crystals should be added to the solution until about 6 lots have been treated. The solution should then be discarded

entirely and a new one made up if more tubers are to be treated. Since delay in germination sometimes results from the treatment it has been found that this may be avoided by treating at least a month previous to planting. It is usually best to treat before cutting. If cut tubers are treated it is well to renew the solution more frequently, as cut tubers weaken the solution much more rapidly than uncut tubers.

Hot formaldehyde. Although the hot formaldehyde treatment is a quicker method than the cold corrosive sublimate treatment, it requires more care and more equipment. The solution used is made by adding 2 pints of commercial formaldehyde (formalin) to 30 gallons of water. This solution is heated up in a tank to 124°-126°F. and the potatoes are then dipped in this hot bath for 3 to 4 minutes. An accurate thermometer, such as a good floating dairy thermometer, is necessary, as the temperature must be accurately controlled and must not exceed 126°F. The equipment for heating the solution need not be elaborate or expensive. Satisfactory results may be obtained with a hog-scalding tank having a tin bottom, the heat being supplied by a wood fire built under the tank. In some districts it is possible to establish seed treating centres at a creamery or other plant where steam is available to heat the solution. Wire baskets are convenient for dipping purposes. If many potatoes are treated, or if the temperature rises too high, more solution will have to be added. A stock solution of the formalin and water mixture should be kept on hand for this purpose. After removal from the solution the treated potatoes should be covered with wet sacks for one hour and then dried. Since delayed sprouting sometimes results from this treatment also, this may be guarded against by treating a month or more before planting.

Cold formaldehyde. This treatment has a number of advantages for the grower who plants only a small quantity of potatoes each year. The solution used consists of 1 pint of formaldehyde to 30 gallons of water, and does not weaken with use. The tubers are soaked for 1½ hours in this solution. Treated tubers are not poisonous. Hence they may safely be used for food if more than the desired quantity needed for seed is treated. Moreover, any kind of containers may be used as the solution does not corrode metals.

New chemicals on trial. Directions for applying the newer disinfectants such as the organic-mercury dips are given on the containers in which they are sold. The acidulated corrosive sublimate treatment has not been standardized as yet, though the proportions of constituents indicated in the table should be satisfactory for preliminary trials. Its chief merit lies in the fact that it is a much quicker method than the old corrosive sublimate method.